the intensity of which is subject to rapid changes, sound may be produced in the phonoscope. Probably by making use of selenium, instead of the tube-transmitter with charcoal, &c., of Prof. Hughes, and by exposing it to light as above, the same result may be obtained.

I should be glad to know whether experiments have been made in this direction; for if the above should prove true, there is no doubt that many applications would be the result.

Kew, June 3 J. F. W.

### Meteor

HAVING just seen a magnificent meteor, I send you an account of it, as from its position it may have been seen at Gibraltar.

At 7.30 this evening a large meteor appeared as nearly as possible N.E. by E. of my position, at about 25 to 28° from the horizon, in a wide opening in the clouds, and proceeded with a moderately fast motion towards the north, slightly descending in a path slightly concave to the horizon. I did not see it disappear, as it went behind some bushes which hid the sky between N. by W. and N. by E.; if it disappeared due N. it would have been about 20° from the horizon as estimated by the altitude of the pole-star. The appearance was very remarkable, the head being of a brilliant green and the tail bright red. When I first saw it I took it for a first-class rocket passing at about 300 or 400 yards from me with a bright Bengal light of green colour at its head. The brightness was certainly from 10 to 15 times that of Venus at its brightest. It shone in the twilight more brilliantly than I ever saw Venus against a dark sky. The tail was not persistent as far as I could judge, against the light sky, and no report was heard, though I listened for several minutes. A bright star, which I believe was Vega, was just below it among the clouds, and afforded a fair standard of comparison; it was from thirty to forty times, at least, brighter than this star. W. A. SANFORD

Funchal, May 27

P.S.—I find that I have forgotten to mention that my position is about two miles south-west of the cathedral of Funchal.

### Multiple Rainbow

ON Saturday evening I (and others) observed a rainbow which presented a very peculiar phenomenon. The primary bow, in the neighbourhood of its apex, was apparently composed of three distinct bows. Just below the violet of the principal bow the bright portion of a second bow was observed, and at about half the distance between the bright portions of these two bows was observed the bright portion of a third bow. The secondary bow looked much as usual, and the principal primary bow was very perfect, so far as I could see, on each side. The repetitions of the primary bow extended only through an angle of 35° or 40°, and did not apparently end at the same point.

Between the point of observation and the sun are some pieces of still water in Bushey Park. Overhead were some clouds upon which the sun was shining. I think the phenomenon was due to the reflection of the sun from the clouds. R. S.

Hampton Wick, June 1

### Opening of Museums on Sundays

MANY of your readers will be glad to know that the very admirable and extensive museum at Maidstone was opened to the public on Sunday last, and will in future be open on Sunday afternoons from two to six o'clock.

The opening was a great success: the mayor and many of the influential inhabitants were present, and more than 1,000 people visited the museum on that afternoon, the average attendance on week-days being from 50 to 100. The most perfect order was preserved, and every part of the museum received its share of attention, even the library being more than full of readers.

I believe that this is the first and only scientific museum that has yet been opened on Sunday in the United Kingdom, the Art Gallery at Birmingham and Aston Hall being of a different character, and so I have thought it worth while to call your attention to it.

For the sake of those who have not yet visited Maidstone Museum I may say that it is one of the best local museums in the country, having remarkably fine palæontological, conchological, and other collections; that it will well repay a visit, or more than one; and that Mr. Bartlett, the courteous curator, is always ready to give visitors any assistance that he can.

Maidstone itself, and the country round, are well worth visiting. I must not forget to mention the cemetery, which is one of the most beautiful in the country.

10, Bolton Row, Mayfair, W., June 10 W. H. CORFIELD, Chairman of the Committee of the Sunday Society

## THE FISHERIES OF BRITISH NORTH AMERICA

### I.

IT was provided by the Treaty of Washington, that, on payment by the United States of a compensatory sum (to be determined by a Commission) to the Dominion of Canada, the Fishing-grounds of British North America should be entirely thrown open to the fishermen of the Union; those of the United States coast, on the other hand, being opened to the fishermen of the Dominion only as far south as the 39th parallel of N. lat., which is almost exactly that of Washington. While the payment of the compensation since awarded by the Commission is being protested against by not a few influential politicians in the United States, the probable influence of the Fishery clauses on the future of the Dominion of Canada is being carefully considered in those parts of it which they especially affect; and we have before us a very able report on this subject by Mr. H. Y. Hind, M.A., a Member of the Legislature of Newfoundland, of which, as based on a careful scientific study of the physical and biological conditions involved in the questions at issue, we think that a summary will prove interesting to our readers.

It is somewhat startling to be told that "as a maritime power the Dominion of Canada stands *fifth* among the nations of the world." This expression, however, is obviously meant by Mr. Hind to refer, not to its *armed* but to its *commercial* marine, which is only surpassed by that of the Mother country, of the United States, of Norway, and of Italy. Its vessels number more than 7,000, and their registered tonnage amounts to above a million and a quarter tons, increasing at the rate of 60,000 tons per annum; its supply of trained seamen is drawn from a fishing population scattered over 3,000 miles of sea-board; and the annual value of their catch reaches at least 20 millions of dollars. The political importance of sea-fisheries as a nursery for seamen, irrespective of the pecuniary value of the catch, is admitted on all hands; and hence it is that a far-sighted policy looks to the value of the British American Coast fisheries as consisting not only in their present productiveness, but also in the security they afford for the maintenance and permanency of what has of late become one of the greatest industries of the Dominion—the work of ocean-carrying.

Now, while the length of the coast-line in British America not covered by previous treaty-arrangements, which is now opened to the United States fishermen, is about 3,700 miles, and the area of its coastal fishing grounds is about 11,900 miles, the length of the United States coast-line opened to British fishermen, is only 1,030 miles, and the area of its fishing-grounds about 3,500 miles. But the respective values of these grounds are not to be estimated by their relative extent alone; for while the United States fishing-grounds north of the 39th parallel were formerly extremely productive, they are now much less so, chiefly through the improvidence of their own people; the cod-fishery, in particular, having been ruined in a great measure beyond repair. On the other hand, the United States coastal waters south of the 39th parallel still maintain much of their original productiveness, supplying a very large quantity of fish to the markets of New York and the South. But to these prolific fishing-grounds access is forbidden to British-American fishermen, who are thus placed at a great disadvantage compared with those of the United States; the latter being

able, when the approach of winter makes the fishing industry of the Dominion coasts hazardous or impracticable, to start at once for the southern grounds, where they can pursue their calling through the winter months. This is so great an advantage, that it frequently renders a northern summer fishery remunerative, which would not be so if the fishermen were dependent upon it alone.

The fish which frequent the United States coast-waters south of the 39th parallel are chiefly of the "anadromous" kind—that is, they live for most of the year in the sea, where they attain the greatest part of their growth, running up into fresh waters for the purpose of spawning. The chief among these are the shad, the alewife or fresh-water herring, the rock-fish, and the striped bass. On the other hand the "commercial" fishes—the cod, herring, haddock, hake, halibut, and mackerel—are found in greatest abundance where the temperature is kept down by the Arctic current, which at the same time furnishes their great store-house of food, and the temperature congenial to them. On the fishing banks of the open sea, the abundance of hake and cod depends essentially upon the resort of herrings; but it is by the "anadromous" fishes that the cod is attracted in-shore. And the destruction of the cod-fisheries which formerly existed on the New England coast is attributed by the United States Fisheries' Commission to the comparative annihilation of the "anadromous" species, through the obstruction and contamination of the river-waters by the various land-industries established along their banks. Below the 39th parallel, however, the "anadromous" fishes find an accessible winter's home in the warm water off the coast of the Southern States, and enter its rivers to spawn as early as February. The United States fishermen being privileged to follow them thither, are thus placed in a position of great advantage as compared with those of the Dominion; the enterprise of the former being stimulated, while that of the latter is cramped, by the Fishery-clauses of the Treaty of Washington, which, as Mr. Hind points out, "place an obstructive boundary on the operations of the British-American fishermen far more limited and confined than formerly existed under the Reciprocity Treaty, while in the same breath they remove every impediment to perfect freedom of action to the United States fishermen throughout an area of great productiveness and practically unlimited extent."

The Physical conditions under which marine life exists on the coasts of British North America, differ in this important particular from those which prevail in the seas of Northern Europe—that while the great modifying influence of the latter is the warm N.E. flow, popularly known as the Gulf Stream, the former are chiefly dominated by the Arctic Current, which brings down glacial *surface*-water from the coasts of Greenland and Labrador. The existence of a low *bottom*-temperature, wherever the basin is deep enough to admit the Arctic under-flow, is common to both: but while, on the European side—to take as an example what I have called the "Lightning" channel that lies N.E. and S.W. between the Orkney and Shetland Islands and the Faroes—the glacial under-flow from the N.E. is overlaid by a comparatively warm upper-flow from the S.W., on the American side the glacial under-flow from the N.E. is overlaid by a cold upper-flow from the same quarter, urged southwards by the prevalence of northerly winds along the Greenland and Labrador coasts. And alike in the upper and in the under south-moving strata is there a *westerly* tendency (caused by the *deficiency* of easterly momentum which they bring from latitudes higher than 60° into lower parallels) which causes them both to "hug the shore" along the whole coast-line not only of British North America, but of the United States. The superficial Arctic wind-current cannot be distinctly traced further south than New York; but none the less is there a band of cold water intervening between the coast-line of the Southern States and the Gulf Stream; and the *Challenger* soundings have distinctly shown the continuity of this band with the deep Polar under-flow which underlies the Gulf Stream, and surges up on the western slope of the Atlantic basin.

The course not only of the superficial Arctic current, but probably also that of the deep under-flow, is greatly modified by local conditions; that of the former chiefly by the strong tides and local winds of the coast, especially in estuaries, straits, or inlets; and that of the latter by variations in depth—the effect of a shallowing bottom being to bring the cold under-flow nearer to the surface. And thus, as Mr. Hind observes, the extraordinary variations which present themselves on the Dominion Coasts are specially worthy of study in their relation to Fish-life. No such peculiarity is more remarkable, than that which seems almost constant in the Strait of Belle Isle, separating the north end of Newfoundland from Labrador; for here, in the latitude of London, the sea has a glacial temperature all the year round. Pack-ice remains in these Straits through the early summer, with a comparatively high air-temperature; and they are never clear of bergs. Sometimes the surface freezes over again at Midsummer after the breaking up of the winter ice. In 1873 the surface-temperature of the sea in these Straits on four consecutive days in the latter part of June was found to range from 36° to 28°; the air-temperature during the same time ranging between 43° and 68°. The extremely little influence which this comparatively high air-temperature had upon the temperature of the surface water, clearly shows that the latter must be constantly kept down by melting ice, and also by the surging-up of the deep glacial underflow. Numerous cases are cited by Mr. Hind of the influence of winds and tides in lowering the surface-temperature by mixing the deep cold stratum with the superficial; the general rule being that easterly sea-winds generally raise the temperature of the surface-water, while westerly winds cool it. That such changes (as from 52° to 38° in a single day) have no relation to the temperature of the winds themselves, is clearly shown by comparative observations of the sea- and air-thermometers; the moist easterly sea-winds being generally colder (at least during summer) than the dry winds crossing from the land; while the influence of a shoaling bottom, lying in the course of the deep glacial flow, is shown by a sudden descent of the surface-temperature to 33°. So, again, a mixing of the different strata produced by currents along the shoaling waters of the Labrador coast, particularly among the islands, rapidly reduces the temperature; so that, in a cold calm after a storm in December, all the conditions are present for that formation of "anchor-ice," of which Mr. Hind gave an account in a former communication. "The sea on the shoals is uniformly cooled; a clear sky and a north wind assist the radiation of heat; and ice-spicules form with great rapidity in the Labrador current, often increased in local intensity by tides." It has been lately stated, on the authority of Prof. Mohn, as a fact well known to the Norwegian fishermen, that the deep water is often so cold that it freezes if disturbed, although it continues liquid so long as it remains perfectly still; fishes passing into such a glacial stratum being frozen, and coming to the surface as lumps of ice.

Mr. Hind draws attention to a remarkable series of observations of temperature and specific gravity, taken by Dr. Kelly, of Quebec, during the Admiralty Survey of the Gulf of St. Lawrence in 1830-36; which show that a very curious temperature-stratification exists in that vast estuary, obviously produced by the mixing of the great body of fresh water brought down by the river St. Lawrence with the cold Labrador current. A zone of water of a certain degree of warmth is superimposed upon a zone sometimes of lower and sometimes of higher temper-

ature; and these zones are cup- or saucer-shaped, having a general relation to the depth in different parts of the Gulf, and sometimes coming to the surface at variable distances from the coast. In every case, however, *the relative position of the zones is strictly accordant with their relative specific gravities;* the overlying of a warmer by a colder zone being due to the dilution of the latter by the admixture of fresh water, as appears from the following examples:—

| | I. | | II. | | III. | |
|---|---|---|---|---|---|---|
| | Temp. | Sp. Gr. | Temp. | Sp. Gr. | Temp. | Sp. Gr. |
| Surface | 54° | 1·0225 | 43° | 1·019 | 51° | 1·0180 |
| 5 fathoms | — | — | — | — | 42·5 | — |
| 10 ,, | 46 | — | 37·5 | 1·023 | 38 | — |
| 20 ,, | — | — | 39 | 1·0246 | 32·5 | 1·0261 |
| 30 ,, | 34·5 | — | — | — | 33 | 1·0266 |
| 50 ,, | 34 | — | 33 | 1·026 | — | — |
| 80 ,, | — | — | — | — | 34 | 1·0266 |
| 100 ,, | 37 | 1·0270 | 36 | 1·0275 | 35 | 1·0271 |
| 150 ,, | — | — | — | — | 35 | 1·0278 |

A similar alternating temperature-stratification has been recently observed by the Norwegian Expedition in the seas between the coast of Norway and the Faroes; and I venture to predict that when the *temperatures* of the successive strata shall have been correlated with their respective *salinities* (which are modified by the admixture of fresh water discharged from the Norway fiords), the stratification will be found conformable to the same law of *the heaviest water lying deepest.*

There is one locality not far distant from our shores, in which similar influences have been found to produce equally decided, though less strongly-marked effects; I refer to the Baltic Straits, in which very careful observations of temperature and specific gravity have now been carried on for several years under the able direction of Dr. Meyer of Kiel, and his coadjutors. Here there is an admixture of waters from three different sources—the North Sea, the Baltic, and the underflow of glacial water which is brought as far south as the Skagerrack by a comparatively deep channel lying outside the Norway fiords. The North Sea brings water of ordinary salinity and of a temperature corresponding generally to that of the air: the Baltic outflow brings a variable quantity of water of low salinity: and the deep Norwegian channel brings water of very low temperature. In addition to these factors, there is the operation of winds and tides, which greatly modify the movements alike of the superficial and of the deeper strata. These influences are now so well understood, that, by a careful correlation of them, the temperature and salinity of the waters at the various observing-stations may be closely predicted; very small differences in specific gravity on the one hand, or small variations in level (and therefore in downward pressure) produced by winds and tides, being sufficient to determine movements in great masses of water, tending to the restoration of the disturbed equilibrium. In fact, as Dr. Meyer assured me during a recent visit to this country, "Your trough-experiment is being daily carried out on the great scale in the Baltic Straits, with the like results."

It is now well-established that the Temperature-stratification of the Sea has, as Mr. Hind says, *an all-important bearing* on the great fisheries:—"It determines the vertical positions in the sea, of the zones of minute and microscopic life which constitute the food of the higher forms, up to those of the fish which feed either directly or indirectly upon them." The cold of the Arctic seas is commonly supposed to be inimical to animal life; but hat the very contrary is the fact, is shown by the abundance of fish along those parts of the British North American coast, whose waters are most reduced in temperature by the Greenland and Labrador current, as compared with their paucity along the New England shores, which are less affected by that current. The most noteworthy case is that of the Strait of Belle Isle, in which, though almost every square mile has been annually fished for more than two centuries, continued productiveness is the rule through an average of years. And thus it becomes clear that the relative extent of the *cold-water areas* which feed (so to speak) the several fishing-grounds of the North American coast, must be a factor of the greatest importance in determining their respective values. Thus, while the water-area within the 100 fathoms' line along the coast of the United States north of Cape Hatteras does not exceed 45,000 miles, that of the British-American coasts within the same limit of depth exceeds 200,000 square miles. And while the former is bounded more or less closely by the heated water of the Gulf Stream, which invades it during the summer months by a swing towards the shore, the latter is only bordered by the Gulf Stream along its southern edge, and is continuous to the north and north-east with a limitless sea of cold water, which is the home of those minute forms of marine life that constitute—directly or indirectly—the source of our "commercial" fishes, the cod, herring, and mackerel.

Another advantage possessed by the fishing-grounds of British North America over those of the United States, is their immunity from the ravages of the *blue-fish*—a voracious wandering fish, whose home is in warm southern waters, its northward migration taking place only during summer, and never extending far beyond Cape Cod. Its destructive agency has had much to do with the diminished productiveness of the New England fisheries; and further south is specially exerted on the mackerel schools. According to the estimate of Prof. Baird, the United States Fishery Commissioner, the weight of fish consumed by the blue-fish of the United States coast during the season is about 300,000 *million* pounds. In its turn the blue-fish is largely consumed as an article of human food, being taken in great numbers along the coast of the Southern States; but it is not suited for salting, and is consequently of no value as an export fish. From the fishing-grounds in which the blue-fish is taken in immense quantities during the early winter months, for the supply of the northern markets, British American fishermen are excluded.

Of the influence which Temperature has now been ascertained to exert over the habits (especially the migrations) of these fishes, and consequently over the productiveness of the great "harvest of the sea" furnished by them, as to which a valuable mass of information has been brought together by Mr. Hind, I shall give some account in a future communication.

WILLIAM B. CARPENTER

## *THE MICROPHONE* [1]

THE following experiments were suggested by the description, which appeared in a recent number of NATURE, of the microphone lately invented by Professor Hughes. Instead of the pointed piece of carbon supported between two pieces of the same material as used by him, it occurred to me that ordinary gas cinders would be likely to answer the purpose tolerably well. To test this, I included in the circuit of an ordinary Bell telephone, a single Leclanchè cell, and a small jelly can half filled with cinders broken into pretty coarse fragments. The connections were made by slipping down at opposite sides, between the cinders and the sides of the

[1] Abstract of a paper read before the Royal Society of Edinburgh on June 3, 1878, by James Blyth, M.A., F.R.S.E.